

**BIGGS CARDOSA
ASSOCIATES INC**
STRUCTURAL ENGINEERS

Kensington Fire Station Seismic Assessment

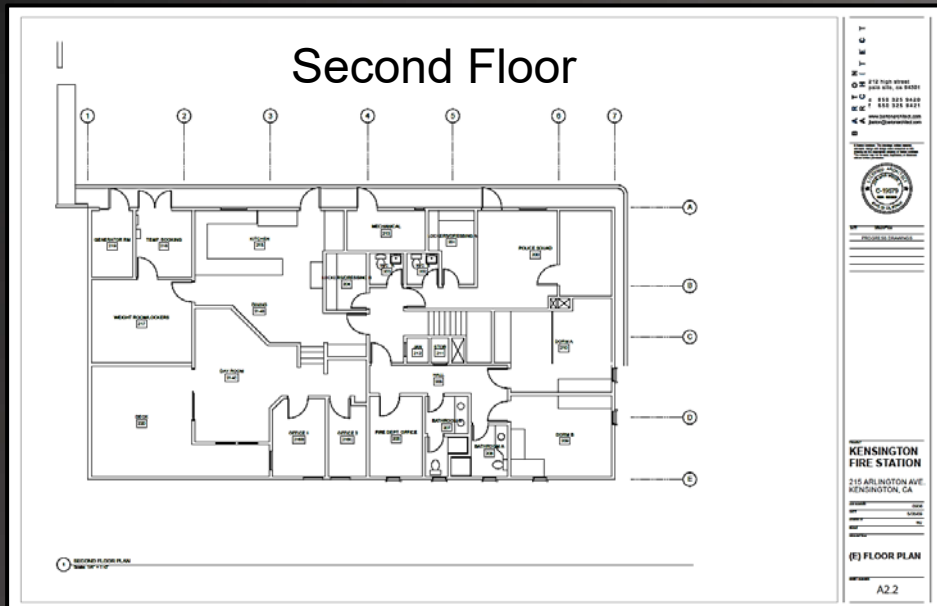
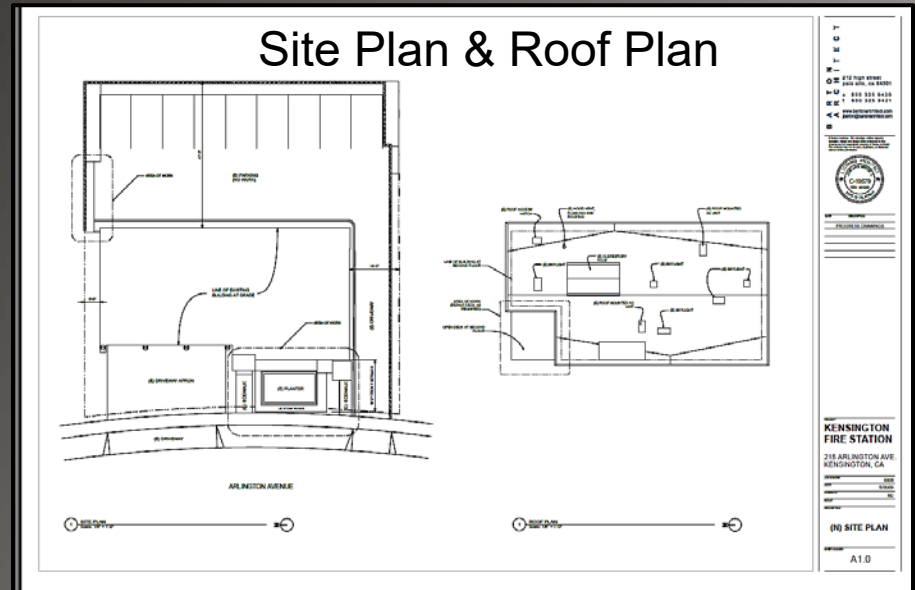
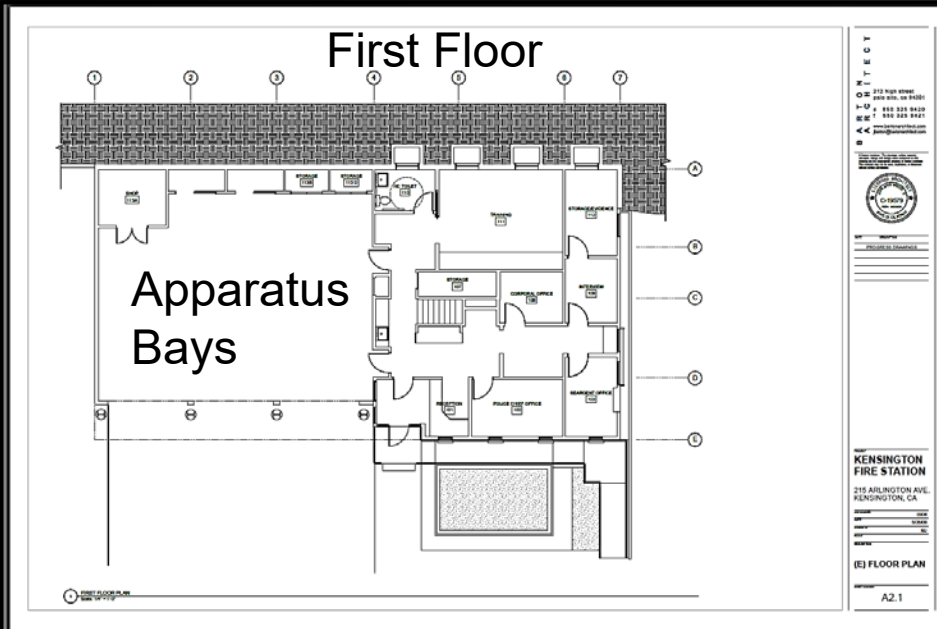


BCA

BUILDING HISTORY & IMPROVEMENTS

- **Built in 1969;** 2 story police & fire station was built on slopping ground.
- **In 1998** it was architecturally remodeled with partial structural seismic upgrade per 1995 California Building Code
- **In 2004** some additional architectural remodeling & partial seismic upgrade was performed per 2001 California Building Code
- **In 2009** drilled reinforced concrete piers were added to correct sliding & settlement of downhill exterior wall & foundation

BUILDING HISTORY



Built in 1969, 5800 S.F., 2 story police & fire station building was built on slopping ground.

- Ground floor level has a rear partial basement, retaining walls & three apparatus bays
- Second Floor is made of wood & steel members & plywood diaphragm
- Roof is made of wood members and plywood diaphragm

AVAILABLE DOCUMENTS USED FOR SEISMIC ASSESSMENT

Assessment was based on limited visual observations of the exposed structural framing, the age, type and condition of the framing, engineering judgment, experience obtained from the evaluation and retrofitting of similar structures and a cursory review of the following original and remodeled design drawings, calculations and reports:

- Original drawings by Jeffries Lyons and Hill, dated 09/19/1969
- Renovation drawings by Marcy Li. Wong and The Crosby Group, dated 09/10/1998
- Structural calculations by The Crosby Group, dated September 1998
- Renovation drawings by Italo A. Calpestri III & Baseline Engineering, dated 06/21/2004
- Structural calculations by Baseline Engineering dated July 27, 2004
- Foundation repair drawings by Biggs Cardosa Associates, dated 06/22/2009
- Soils report by Woodward-Clyde and Associates, dated May 28, 1969
- Soils report by Seidelman Associates, dated 06/8/1990
- Soils report by Geomatrix, dated October 1997
- Soils report by Kleinfelder, dated May 5, 2009

PARTIAL SEISMIC UPGRADES

- In 1998 remodel portions of structure were seismically upgraded
 - Holdowns were added at ground floor & 2nd floor levels at interior common wall.
 - To eliminate soft story at apparatus bay openings, a three bay steel rigid frame in drilled reinforced concrete piers was added along with a continuous collector at second floor level.
- In 2004 building was again remodeled and some additional seismic strengthening was performed. The steel rigid frame installed during the 1998 remodeling was strengthened to meet the requirements of the 2001 CBC and additional plywood sheathing was added to the other side of the shear wall at the common wall between the office space and the apparatus bays.
- Both 1998 remodel & 2004 seismic strengthening were partial upgrades.
- Partial seismic upgrades to meet the 1995 and 2001 California Building Code requirements were performed.

JANUARY 2016 OBSERVATIONS

- Some cracks in interior gypsum board walls
- Floor slab slope has not worsened since 2009 drilled piers installation
- Cracks in apparatus bay floor slab
- Large crack in concrete curb & top of retaining wall at southwest corner of outside accessibility ramp at entrance to station
- Some cracks in sloping asphalt pavement of driveway leading up to back parking lot

EARTHQUAKE FAULTS

Our review of the geotechnical reports for the building site points out that this site is located within the State of California Earthquake Fault Study Zone, which means that this site is in a region of high seismic activity. The geotechnical reports indicate that the following active faults are within close proximity of the station:

- The main trace of Hayward Fault passes approximately 300 to 400 feet west of Arlington Avenue.
- San Andreas Fault is located approximately 19 miles southwest of the site.
- Rodgers Creek-Healdsburg Fault is located approximately 12.5 miles north of the site.
- Calaveras Fault is located approximately 18 miles east to southeast of the site.

CHANGES IN SEISMIC DESIGN CRITERIA & LOADS

- To improve public safety, over the years there have been many changes in the Uniform and California Building Codes regarding the minimum requirements for the structural design of a building. These changes have affected both gravity and lateral loads.
- These older buildings do not include the new structural details required to resist earthquake forces and will not perform as well during an earthquake.
- Recent codes have improved the safety of newer structures by the increase in the numbers and types of inspections required during construction
- Seismic design forces have substantially increased since station was originally built.
- Police & fire stations are essential facilities and require immediate occupancy after a seismic event. The more recent codes require that police and fire stations be designed with an importance factor that increases the seismic design forces to a higher level than other buildings.
- Comparison of seismic design requirements for base shear of 1967 Uniform Building Code to 2013 California Building Code:
 - The 1967 Uniform Building Code required Seismic Base Shear Loads = 13.3 % of building weight
 - The 2013 California Building Code requires Seismic Base Shear Loads = 26.0 % of building weight
 - If designed today, the new code would require 2 X the seismic base shear forces as the original station

PROBABLE STRUCTURAL DEFICIENCIES & DAMAGES

- Recent codes have substantially increased the minimum loads and forces to be used in the design of buildings.
- These newer codes have also required that stronger connections be used in the design and construction of buildings.
- Based on the age of the building, the type and condition of the existing framing, engineering judgment, experience obtained from evaluating similar buildings, and since the minimum design forces have increased along with the requiring stronger connections; in our opinion the following existing structural elements are probably deficient:
 - The plywood floor and roof diaphragm
 - The connection of the plywood floor and roof diaphragm to the shear walls
 - The plywood shear walls
 - The anchorage of the plywood shear walls to the foundation
 - Foundations

CONCLUSIONS & RECOMMENDATIONS

- **EXISTING CONDITION:** Although no major signs of distress or damage were observed, the noted deficiencies do indicate that the structure is vulnerable to seismic loading. The building has been well maintained over the years. Minor cracks in the interior gypsum board walls were observed. No settlements in the existing basement retaining walls or building foundations were observed. No cracks or damage to the exterior finishes were observed. Cracks in the apparatus floor slab were observed but due to the age of the slab and the heavy loading of the fire trucks these cracks are normal and are to be expected.
- **CODE COMPLIANCE:** The building does not meet the requirements of the newer codes and as a Police and Fire Station; it is an essential facility and therefore is required by code to have immediate occupancy after an earthquake. When the building was originally designed there were no special design requirements for this type of building. However, later codes recognize that this type of facility must allow for continuous operation after an earthquake. Because the station is located in a very active seismic zone, the code requires that higher seismic forces be used in the design of the building. These higher seismic design code forces for this location are approximately two times the seismic forces used in the design for the original building in 1969.
- **PARTIAL UPGRADE:** On two occasions the station has had partial seismic upgrades performed during architectural remodeling projects. These seismic upgrades have improved the ability of the building to resist earthquakes forces but since they were only partial upgrades, it is our opinion that the building still does not meet the requirements of the newer codes. This building, because of its age and the newer code requirements, does have structural deficiencies and will not perform as well as a new building during an earthquake. Because the building does not meet the latest seismic code requirements and due to its proximity to major earthquake faults there is the possibility that significant structural damage may occur with loss of life during a seismic event.
- **BCA'S RECOMMENDATION:** We recommend that the existing building be replaced or fully evaluated based on the requirements of the 2013 California Building Code by a registered Structural Engineer to determine the structural framing elements that are deficient. Please note that a replaced structure will not only perform much better during an earthquake but address many of operational issues of the existing station.